3D Miniature Solar System Media for Elementary Science Learning

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Abstract. General Background: Education plays a crucial role in developing students' potential through meaningful and effective learning processes, particularly in science education at the elementary level. Specific Background: Solar system material is abstract and difficult for sixth-grade students to understand, while classroom practices tend to rely on digital media with limited innovation in non-digital learning tools. Knowledge Gap: There is a lack of interactive and concrete learning media that can visualize abstract scientific concepts and actively involve students during the learning process. Aims: This study aims to develop and evaluate a 3D miniature solar system learning media using the ADDIE model to support science learning for sixth-grade elementary students. Results: The developed media achieved a validity score of 100% from media experts, lesson plans, and material validation, while effectiveness results reached 96% based on teacher responses and 95% from student questionnaires, indicating a very high level of feasibility. Novelty: The study presents a manually operable and dynamo-supported 3D miniature solar system model that enables multi-angle observation and active student interaction in learning activities. Implications: The implementation of this media supports active student engagement, facilitates understanding of abstract solar system concepts, and provides a meaningful classroom learning experience for elementary science education.

Keywords: 3D Miniature, Solar System Learning, Elementary Science Education

1 Introduction

Education can be defined as a conscious and planned effort to create a learning environment and learning process so that students can actively improve their potential. This potential includes several components, such as spiritual strength, self-control, character, intelligence, noble character, and skills needed by the individual and society. Overall, education serves as an effort made by humans to strengthen and awaken their physical and spiritual potential in accordance with the values that apply in society and culture. Education and culture are interrelated in the effort to advance a nation that cannot be separated. Thus, education can be developed according to individual abilities to optimally improve intelligence and potential[1]. This is important to improve and create a generation with high integrity, empathy, and social adaptability in facing increasingly complex global challenges. From a comprehensive approach, education can be an effective strategy or tool in shaping the character of each individual, who

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plays a role in building empathy and contributing positively to the surrounding community and nation[2].

The objectives of national education as contained in Law No. 20 of 2003 concerning the National Education System, Chapter II Article 3 states that National Education has the function of developing the ability to build character and a dignified national civilization in order to improve the intelligence of the nation, with the aim of developing the potential of students so that they can become people who believe in and fear God Almighty, have noble character, are healthy, knowledgeable, skilled, creative, independent, and become democratic and ethical citizens with a responsible spirit[3]. Education is a process of shaping a person's character (soul) in order to increase their potential and abilities. Education is capable of producing quality human resources through the acquisition of quality education. Improving the quality of education can demonstrate an effort to obtain quality education and teaching in schools. The education system is said to be of high quality in terms of process if students obtain a meaningful learning process and the learning process in the classroom is effective. In order to create a meaningful learning process, the learning process in the classroom must be effective[4].

Elementary school levels have established Natural Sciences (IPA) learning, which plays an important role in developing their knowledge of the natural world[5]. Natural Sciences (IPA) is a branch of science that focuses primarily on learning through natural phenomena obtained from the results of scientific investigations using experimental skills and methods. The purpose of studying Natural Sciences (IPA) is to introduce basic scientific concepts in everyday life and technology that are relevant to daily life. In Natural Sciences (IPA) learning, students are encouraged to observe directly, explore knowledge, and find out about the phenomena around them. Overall, Natural Sciences (IPA) learning in elementary school is oriented towards transferring knowledge through direct involvement with the surrounding environment using interactive, exploratory, and collaborative teaching methods so as to increase the effectiveness of learning, student motivation, build their own knowledge, interest in learning, and skills[6].

The essence of science learning in Jean Piaget's constructivist theory is a learning process in which students can actively construct new knowledge, new concepts, and new understandings based on data[7]. One of the topics in science learning for sixth grade elementary school students is the solar system. The solar system is a series of celestial bodies consisting of the sun as the center of the solar system, various planets, a collection of satellites, comets, meteors, and asteroids, which are just a few of the millions of stars arranged in a group (classification) called a galaxy. A galaxy contains several large collections of objects such as stars, gas, dust, and other celestial bodies. There are thousands of galaxies in the universe with enormous distances between them, and each galaxy is very large. The galaxy is where the sun, as one of its members, is located, and it is named the "Milky Way" galaxy[8]. Solar system material is one of the most difficult subjects for students to understand because it is abstract, idealistic, and logical[9].

Based on observations and interviews conducted by researchers in the sixth grade of SDS Muhammadiyah Ngoro with sixth grade elementary school teachers regarding the teaching of natural sciences (IPA), particularly in the subject matter of the solar system, it was found that during the teaching process, teachers tended to use digital media, resulting in a lack of innovation in non-digital learning media during the teaching process in the classroom. The lack of innovation in non-digital learning media in the classroom can also cause students' motivation and interest in learning to decline,

especially in science (IPA) learning, because the learning material is quite difficult for students to understand due to its abstract nature. Therefore, the researcher was interested in developing a 3D miniature solar system learning medium for sixth grade elementary school students to provide a realistic visualization of solar system learning material during the learning process in the classroom by actively involving students as a whole. Active student involvement in the learning process will create and build meaningful new knowledge, understanding, and concepts so that overall student learning effectiveness can be achieved.

Technology today can dominate people, from children to adults, causing them to continuously use and access technology, which can lead to a decline in the effectiveness and quality of student learning. The quality of learning is an indicator or key component of the effectiveness of an education system. Effective learning is the result obtained after implementing a learning process that is beneficial in everyday life[10]. It can be concluded that effective learning is a series of activities during the learning process that students obtain from their experiences and environment, which bring certain benefits, influences, and meanings. Indicators of the effectiveness of successful learning include: 1) Management of the learning process, meaning the strategies used by teachers to control situations and conditions conducive to learning by making thorough preparations before the lesson begins, mastering the material as a whole, presenting important topics in the lesson, and providing opportunities for students to ask questions. 2) Communicative teaching and learning process, which refers to a series of learning activities that emphasize the communication component to convey ideas through two way communication from the teacher to the students with *feedback*. 3) Student response refers to the learning process in which students actively respond and react to the learning material, what they know, and the questions asked by the teacher during the learning process. 4) Student learning activities refer to activities or tasks during the learning process between the teacher as the provider of information and the students as the recipients of information to achieve successful teaching quality by utilizing the senses, intellect, and mind[11].

According to Jean Piaget, the stages of human cognitive development are divided into several phases, one of which is the concrete *operational* stage. This stage occurs between the ages of 7 and 11, when children begin to think and reason logically about real experiences and events (reality)[12]. Concrete operational behavior is related to real objects. The concrete operational stage accommodates several characteristics and abilities of children with a focus on qualities and characteristics that can be observed through objects, rather than conceptual ideas[13]. At this stage, teachers play a major role in the learning process, where they are expected to present and deliver material related to real objects so that students can easily understand and respond to the information provided. Presenting information through real objects can make it easier for students to respond to and understand the material that has been presented. Teachers are required to create creative and innovative learning media that are used to convey messages or information in the form of learning materials in order to increase student interaction during the learning process, so that students do not get bored during class. In other words, to achieve this, there needs to be real learning media (reality)[14].

Learning media is essentially a very important tool in the learning process for conveying messages (information) from teachers to students as recipients of information. In this context, learning media is not just a learning tool, but has a strategic role in creating an effective and comprehensive learning atmosphere. In general, the function and benefit of learning media is to develop targeted communication skills

between teachers and students in order to create an optimal learning environment[15]. The main function of learning media is to achieve instructional objectives, whereby the messages or information contained in the learning media must engage students both mentally and physically during the learning process. By using the right learning media, learning activities can be carried out efficiently, depending on the learning objectives, material, and characteristics of the students[16].

Miniatures can be defined as replica objects such as places, buildings, food, and other objects that can be viewed from various angles. In the past, miniatures were simply used as props in art performances and as smaller-sized research models. However, with the passage of time, miniatures can now be used as a learning medium that suits the needs of students in learning[17]. Miniatures can present concepts visually and realistically in learning, making it easier for students to explore the material presented by the teacher. Miniatures are learning media that are identical in form to the original but presented in a smaller size than the original. Thus, miniatures are not only learning aids but also innovative strategies to support effective and relevant learning processes. The application of miniatures in the context of education allows students to interact directly with objects that can be studied in reality during the learning process[18].

Development of 3D miniature learning media as a supporting tool during classroom learning. The development of learning media can be defined as a process or method used to validate a product and develop it further. The solar system cannot be seen directly by the naked eye (abstract). Therefore, it is necessary to develop relevant learning media to provide students with detailed explanations of the learning material[19]. The 3D miniature solar system learning media is a three-dimensional teaching aid for teachers during the learning process that can be rotated manually and uses a dynamo to observe the movement of the planets around the sun, which appears smaller than its actual size. This media can be observed from any angle to make it easier for students to explore the learning material, thereby maximizing the effectiveness of student learning[20]. This learning media serves to facilitate students during the learning process, where students can see and move the 3D miniature learning media directly. Through this learning media, it is hoped that students can be directly involved during the learning process. In addition, the development of 3D miniature learning media can provide (create) a more interesting and meaningful learning experience that can have a significant positive impact on the effectiveness of education at the elementary school level.[21]

2 Method

This study uses a *research and* development *(R&D*) approach to produce (create) innovative learning media. R&D (*Research and Development)* is a systematically structured approach that can be used to generate new knowledge, solve problems, or develop products, processes, or services. The *R&D* model was chosen because it allows researchers to produce learning media products. In addition, researchers also test the validity and effectiveness of media development in the context of learning. In this study, the focus of the development is 3D miniature learning media specifically designed for the subject of Natural Sciences (IPA) on the solar system for sixth grade elementary school students.

The development process of this 3D miniature learning media follows the ADDIE model. According to Robert Maribe Branch, the ADDIE model is a learning system design model that consists of a series of basic learning stages that are simple and easy to learn. The learning design process is to direct, determine methods and procedures, develop strategies, and be goal-oriented. The ADDIE model (*Analysis, Design, Development, Implementation, and Evaluation*) describes a general paradigm for instructional design. The ADDIE development model (*Analysis, Design, Development, Implementation, and Evaluation*) is a model of design for teaching and learning based on an effective, efficient, and interactive system[22].

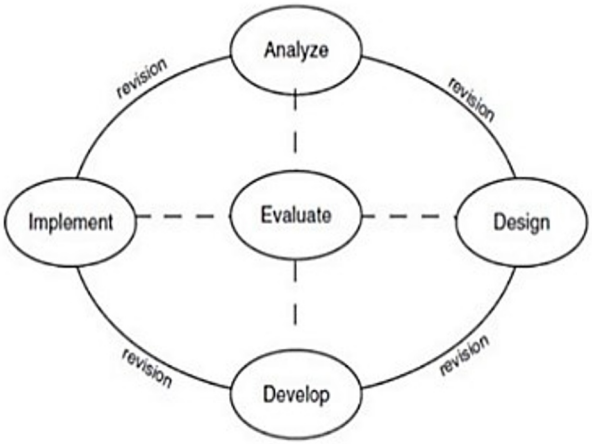

Fig. 1. Research Stages of the ADDIE Model.

The ADDIE model stages are outlined in the first stage of the ADDIE model; analysis, in which an analysis of learning needs, student targets, learning materials, and student characteristics is carried out[23]. The second stage is design, which involves designing learning media specifically tailored to the needs of sixth-grade elementary school students. The third stage is development, which involves developing product plans in terms of both learning materials and media. The fourth stage is implementation, which involves applying the learning media to students. The final stage is evaluation, which is carried out to measure the feasibility and effectiveness of the learning media by providing response questionnaires.

The development process and data collection procedures in this study were carried out in stages, in accordance with the ADDIE model used; 1) The analysis stage was conducted through in-depth interviews with teachers and several sixth-grade students at SDS Muhammadiyah Ngoro Elementary School to identify needs during the learning process, as well as initial observations of classroom conditions. At this stage, the researcher analyzed the subjects and learning materials that would later be used in developing learning media. In addition, the researcher identified student characteristics through observation during the learning process in the classroom. The analysis of student characteristics aimed to identify the learning habits applied by teachers to students during the learning process in the classroom. Through the analysis of student characteristics in the classroom, it was hoped that the stage of student development during learning could be identified so that the learning media to be applied could be adjusted to the students' level of understanding. 2) *Design* stage: In this stage,

researchers created a design for 3D miniature learning media for science learning, specifically for solar system material in sixth grade elementary school, starting from the visual form of the media, the materials used, how to operate (use) the media, to the characteristics of the learning media. At this stage, the researcher compiled research instruments that were given to experts to determine the feasibility and suitability of the media, with benchmarks that included components in line with the objectives, practicality and simplicity, flexibility, and economy and affordability. This design stage also involved creating specifications regarding the writing style, media form, appearance, colors, and student needs related to learning media in the classroom. The learning media display contained elements such as a collection of planet names, various celestial objects, learning quizzes, various planets, and the sun as the center of the solar system, which could be moved to increase the overall active involvement of students during the learning process in the sixth grade. 3) Development stage: at this stage, the researcher implements (realizes) the development of learning media from the results of the analysis in stage 1 and the design in stage 2 by refining the design, which is then realized. This realization refers to the development of a 3D miniature solar system learning medium into a medium that is ready to be validated by experts. The purpose of this validation test is to determine whether the 3D miniature solar system medium is valid or not. After conducting a validation test with experts, the next stage is for researchers to refine the product based on suggestions, input, and responses from experts. 4) The 3D miniature solar system learning media, which has been refined based on suggestions, input, and feedback from experts, then proceeds to the next stage, which is implementation. At this stage, the researcher implements the 3D miniature solar system learning media or conducts a trial during the learning process with sixth-grade elementary school students. The purpose of implementing or testing this 3D miniature solar system learning media is to measure the feasibility of the learning media. 5) Evaluation stage. At this stage, the effectiveness and relevance of the learning media that has been implemented is determined, with benchmarks that include components that are in line with the objectives, practical and simple, as well as flexible. In this stage, the researcher also distributed and collected feedback (response questionnaires) from teachers and students. Based on the results of the response questionnaires given to teachers and students, improvements were made to the media so that it would not only be effective in improving student understanding but also suitable for use in learning at SDS Muhammadiyah Ngoro.

The following is the formula used to calculate the score obtained from the assessment results of media experts, lesson plan experts, subject matter experts, teacher response questionnaires, and student response questionnaires[24].

$$\text{Assessment Percentage} = \frac{\sum x}{\sum xi} \times 100\% \quad (1)$$

Explanation:
P : Assessment Percentage
$\sum x$: Total score obtained
$\sum x\,i$: Maximum score
100% : Constant

The following percentages are used to reinforce the data from the media expert validation, lesson plans (RPP), and materials using the average analysis standard in the following table.

Table 1. Product Validity Criteria.

Validity Percentage	Criteria
81% - 100%	Highly Valid
61% - 80	Valid
41% - 60	Fairly Valid
21% - 40	Less Valid
0% - 20	Very Insufficiently Valid

Table 1 shows the product validation score criteria. The scores are obtained from the validators' assessments. A product is considered "valid" if the achievement level is in the valid category, meaning that the product can be used[24].

The following is a presentation used to reinforce the assessment data provided to teachers and students using the average analysis standard in the following table.

Table 2. Product Effectiveness Criteria.

Validity Percentage	Criteria
0% - 20	Very Ineffective
21% - 40	Less Effective
41% - 60	Fairly Effective
61% - 80	Effective
81% - 100%	Very Effective

Table 2 shows the criteria for product effectiveness scores. The scores were obtained from the results of questionnaires completed by teachers and students. A product is considered "effective" if the achievement level is in the effective category[25].

3 Results and Discussion

The results of this research development produced a product in the form of a 3D miniature solar system media, which is a medium for learning Natural Sciences (IPA), especially in the solar system material content in the sixth grade of elementary school. The learning media has passed the expert validation stage, product testing, and product response testing by teachers and sixth grade students at SDS Muhammadiyah Ngoro Elementary School. The development of learning media using the ADDIE development model was obtained as follows.

3.1 Analysis Stage

The analysis stage involves analyzing learning needs, student targets, learning materials, and student characteristics. The participants in this study were sixth-grade students at SDS Muhammadiyah Ngoro, who were selected using purposive sampling, as the researcher chose the school based on criteria and objectives relevant to the study. The researcher conducted a learning needs analysis by interviewing teachers and several sixth-grade students at SDS Muhammadiyah Ngoro, as well as conducting preliminary observations of the conditions in the classroom. Based on the results of interviews with teachers and several sixth-grade students at the elementary school, it was found that there was a lack of innovation in the use of non-digital media, resulting in students in the class being less actively involved overall during the learning process.

The lack of innovation in learning media in the classroom can cause students' interest and motivation to learn to decline[26] .

At this stage, the researcher also analyzed the subjects and learning materials used by the researcher through observation with sixth grade teachers at SDS Muhammadiyah Ngoro. This analysis of subjects and learning materials will later be used to develop a product in the form of learning media for sixth grade elementary school students in Natural Sciences (IPA) learning. These learning materials were chosen because most students experience a decline in interest, lack of active involvement, and difficulty understanding solar system material due to the learning materials being quite difficult for students to understand and the subject matter being abstract in nature.

After analyzing the subjects and learning materials, the next step is to adjust the analysis results to the characteristics of sixth-grade elementary school students. The analysis of student characteristics in the classroom aims to determine the stage of student development during the learning process so that the media to be applied can be adjusted to the students' level of understanding. In the learning process in the classroom, teachers generally present digital learning media to explain the material. The presentation of learning media helps students understand the learning material, but there are still some students who are not fully engaged in the learning process. To overcome this problem, the learning media that is suitable to be developed and applied in sixth grade is 3D miniature solar system learning media.

3.2 Design Stage

At this stage, researchers designed a natural science learning medium, specifically covering solar system material for sixth grade elementary school students, including the visual form of the medium, the materials used, how to operate (use) the medium, and the characteristics of the learning medium. The 3D miniature solar system learning media was designed as a supporting tool during the learning process in sixth grade elementary school to present the atmosphere of outer space. The learning media display contains elements such as a collection of planet names, various celestial objects, learning quizzes, various planets, the sun as the center of the solar system, and instructions on how to use the learning media. This learning media is made from tools and materials that are easily obtained in the surrounding environment, including 1) plywood as the base of the media, 2) clay or plasticine to visualize the shape of the planets as they are in reality, 3) wire to arrange the planets in sequence on the learning media, 4) plastic balls and buffalo paper in the shape of the sun in the center to give the impression of the sun as it is in reality, 5) A quiz box made of cardboard covered with flannel fabric containing a collection of questions which will later be given to students to create an active and interactive learning atmosphere in the classroom, 6) Printed letters to display the names of the planets, 7) A dynamo to show the movement of the planets as they revolve around the sun, 8) Batteries, 9) A battery switch used to turn on and off the flow of electricity from the battery, and 10) Star-shaped beads to give the impression of stars in the universe in general.

The 3D miniature solar system learning media can be rotated (moved) manually and using a dynamo to observe the movement between planets orbiting the sun, which can be observed from any angle to help students explore the subject matter. This learning media can provide a concrete visualization of the solar system in a smaller size, can involve students actively throughout the learning process, and its innovative and interactive design can increase student motivation to learn. In addition, the quiz box on

the learning media can help teachers measure the extent of students' understanding. At this stage, the researchers also developed research instruments that were given to experts, teacher response questionnaires, and student response questionnaires.

3.3 Development Stage

At this stage, researchers implemented (realized) the development of a 3D miniature solar system learning media based on the analysis in stage 1 and the design in stage 2. The development of learning media was carried out by creating learning media according to the steps that had been made. The development of this 3D miniature solar system learning media is intended to facilitate students during the learning process, where students can see and move the 3D miniature solar system learning media directly. Through this learning media, it is hoped that students can be directly involved during the learning process and find it easier to learn about the solar system in Natural Sciences (IPA) in the sixth grade of elementary school.

Fig. 2. Display of 3D Miniature Solar System Learning Media

The instrument used in this study was a questionnaire given to experts using a Likert scale, including: (4) Very Good, (3) Good, (2) Fairly Good, and (1) Poor.

Table 3. Results of Media Expert Validation

Assessment Aspect	Assessment Indicators	Score
Component Aspects in Line with Objectives	1. The learning media was created in accordance with the solar system learning material for sixth grade elementary school students.	4
	2. 3D miniature solar system learning media created in accordance with the CP and TP in the lesson plan	4
	3. 3D miniature solar system learning media can make it easier for students to remember (strengthen long-term memory) solar system material	4

Continued **Table 3.**

Assessment Aspect	Assessment Indicators	Score
Component Aspects in Line with Objectives	4. The learning media was created in accordance with the solar system learning material for sixth grade elementary school students.	4
	5. 3D miniature solar system learning media created in accordance with the CP and TP in the lesson plan	4
	6. 3D miniature solar system learning media can make it easier for students to remember (strengthen long-term memory) solar system material	4
	7. 3D miniature solar system learning media can provide students with new knowledge	4
	8. 3D miniature solar system learning media can provide students with new experiences	
Practical and Simple Aspects	9. Instructions for using the 3D miniature solar system learning media are easy to understand	4
	10. The 3D miniature solar system learning media is easy to use	4
	11. The colors presented in the 3D miniature solar system learning media accurately represent the actual colors of the solar system	4
Flexible Aspect	12. The color presentation in the 3D miniature solar system learning media accurately represents the actual colors in the solar system	4
	13. The 3D miniature solar system learning media is designed to actively engage students during the learning process.	4
Economical and Affordable	14. The cost of producing 3D miniature solar system learning media is very affordable	4
	15. The materials used can utilize items found in the surrounding environment (the sun from a toy ball, the sun's rays from a pen, the planet's orbital paths from wire, and the planet's rotation mechanism from a toy wheel)	4
Number of Values		**48**
Maximum Value		**48**

Based on Table 3 of the media expert validation results above, it is known that the total score given is 48 and the maximum score is 48. From this data, the validity test formula is calculated as follows.

$$\text{Assessment Percentage} = \frac{48}{48} \times 100\%$$
$$= 1 \times 100\%$$
$$= 100\%$$

From the results of the data calculation above, the media expert validity percentage is 100%. Looking at the validity criteria table, it shows that the validity criteria of 81%-100% is stated in the validity criteria as "Very Valid". In this research

instrument, media experts also provided comments and suggestions that this learning media is deemed suitable for testing.

Table 4. Results of the Validation of the Lesson Plan (RPP)

Assessment Aspect	Assessment Indicators	Score
Identification	1. There is an identity of the educational unit, including the author, school level, institution, year of author, subject, phase/class, material, and time allocation	4
	2. There is identification of students	4
	3. There is identification of learning materials	4
	4. Contains several relevant Graduate Profile Dimension (GPD) identifications within the scope of the material	4
	5. There are Learning Outcomes, namely students are able to understand the structure of the solar system and the characteristics of the solar system	4
	6. There is an interdisciplinary approach	4
	7. There are Learning Objectives, as follows: a. List the structure of the solar system and the characteristics of its members b. Classify the types of planets based on their distance from the sun c. Determine the types of planets based on their distance from the sun	4
Learning Design	8. There are learning topics	4
	9. The existence of pedagogical practices, including models, approaches, and learning methods that are appropriate to the scope of the material	4
	10. There are learning partnerships	4
	11. The existence of a learning environment, including physical space, learning media, and student learning culture that are appropriate to the scope of the material.	4
	12. There is the use of non-digital and digital media according to needs, actively involving students during learning activities	4
Learning Experience	13. There are initial learning activities to prepare students both physically and mentally before starting learning activities with the necessary time allocation (5 minutes) during classroom learning activities.	4
	14. There are core learning activities in accordance with the syntax of the Direct Learning model (media-based direct learning) with the necessary time allocation (60 minutes) during classroom learning activities.	4
	15. There are closing learning activities to provide feedback and summarize the material that has been learned with the necessary time allocation (5 minutes) during classroom learning activities.	4
References	16. There is a list of references that correspond to the learning materials for Grade VI of Elementary School	4

Continued **Table 4.**

Assessment Aspect	Assessment Indicators	Score
Identification	17. There is an identity of the educational unit, including the author, school level, institution, year of author, subject, phase/class, material, and time allocation	4
	18. There is identification of students	4
	19. There is identification of learning materials	4
	20. Contains several relevant Graduate Profile Dimension (GPD) identifications within the scope of the material	4
	21. There are Learning Outcomes, namely students are able to understand the structure of the solar system and the characteristics of the solar system	4
	22. There is an interdisciplinary approach	4
	23. There are Learning Objectives, as follows: d. List the structure of the solar system and the characteristics of its members e. Classify the types of planets based on their distance from the sun f. Determine the types of planets based on their distance from the sun	4
Learning Design	24. There are learning topics	4
	25. The existence of pedagogical practices, including models, approaches, and learning methods that are appropriate to the scope of the material	4
	26. There are learning partnerships	4
	27. The existence of a learning environment, including physical space, learning media, and student learning culture that are appropriate to the scope of the material.	4
	28. There is the use of non-digital and digital media according to needs, actively involving students during learning activities	4
	29. There are initial learning activities to prepare students both physically and mentally before starting learning activities with the necessary time allocation (5 minutes) during classroom learning activities.	4
Learning Experience	30. There are core learning activities in accordance with the syntax of the Direct Learning model (media-based direct learning) with the necessary time allocation (60 minutes) during classroom learning activities.	4
	31. There are closing learning activities to provide feedback and summarize the material that has been learned with the necessary time allocation (5 minutes) during classroom learning activities.	4
References	32. There is a list of references that correspond to the learning materials for Grade VI of Elementary School	4
Total Score		**64**
Maximum Score		**64**

Based on Table 4, the results of the validation of the Lesson Plan (RPP) above show that the total score given is 64 and the maximum score obtained is 64. From this data, the validity test formula is calculated as follows.

$$\text{Assessment Percentage} = \frac{64}{64} \times 100\%$$
$$= 1 \times 100\%$$
$$= 100\%$$

From the results of the data calculation above, the validity percentage of the Lesson Plan (RPP) is 100%. Looking at the validity criteria table, it shows that the validity criteria of 81%-100% is stated as "Very Valid". In this research instrument, experts also provided comments and suggestions that this learning media is deemed suitable for use.

Table 5. Expert Material Validation Results

Assessment Aspect	Assessment Indicators	Score
Components in Line with Objectives	1. Material Alignment with Learning Outcomes (CP)	4
	2. Alignment of material with Learning Objectives (LO)	4
	3. Material suitability with grade level	4
	4. Appropriateness of material to media used	4
	5. Content suitability	4
Total Score		**20**
Maximum Score		**20**

Based on Table 5 of the expert material validation results above, it is known that the total score given is 20 and the maximum score obtained is 20. From this data, the validity test formula is calculated as follows.

$$\text{Assessment Percentage} = \frac{20}{20} \times 100\%$$
$$= 1 \times 100\%$$
$$= 100$$

From the results of the data calculation above, the validity percentage of the subject matter experts was 100%. Looking at the validity criteria table, it shows that the validity criteria of 81%-100% is stated as "Very Valid". In this research instrument, the subject matter experts also provided comments and suggestions that this learning media is deemed suitable for use.

3.4 Implementation Stage

At this implementation stage, researchers implemented or tested the 3D miniature solar system learning media in the sixth grade of SDS Muhammadiyah Ngoro with 25 students. The purpose of testing this learning media was to measure its feasibility. During the product trial, the sixth-grade elementary school teacher stated that the media was easy to operate and helpful in explaining material concepts, such as the types of celestial bodies and the order of the planets. At the beginning of the learning activity, the teacher explained how to use the learning media and introduced the names and characteristics of each solar system. In the core learning activity, the teacher divided the students into several learning groups. Each group representative was asked to take a quiz on the learning media, and students were asked to discuss and answer the learning

quiz with their group members. Students who were assigned to the first group were asked to answer and determine the names of the planets according to the quiz they received and to conduct an experiment on the movement of planets around the sun with their group members so that all students could be actively involved. At the end of the learning activity, the teacher provides direct feedback in the form of praise if the answers are correct, or guidance if there are errors in expressing opinions in the learning quiz. After the activity, the researcher distributes and collects response questionnaires given by teachers and students at the evaluation stage.

3.5 Evaluation Stage

The learning media that had gone through the stages of analysis, design, development, and implementation then proceeded to the final stage, which was evaluation. At this stage, the researcher distributed and collected response questionnaires given to teachers and students to determine the effectiveness and relevance of the learning media that had been implemented in grade VI of SDS Muhammadiyah Ngoro. The instrument used in this study was a response questionnaire given to teachers using a Likert scale, including: (4) Very Good, (3) Good, (2) Fairly Good, and (1) Not Good. In addition, to determine student responses, a student response questionnaire was used with a Guttman scale, including: (1) Yes and (2) No.

Table 6. Teacher Response Questionnaire on Learning Media Trial

Assessment Aspect	Assessment Indicators	Score
Components in Line with Objectives	1. 3D miniature learning media of the solar system made in accordance with the solar system learning material in Grade VI Elementary School	4
	2. 3D miniature solar system learning media created in accordance with the CP and TP in the lesson plan	4
	3. 3D miniature solar system learning media can help students remember (strengthen long-term memory) solar system material	3
	4. The 3D miniature solar system learning media can provide new knowledge for students	4
	5. 3D miniature solar system learning media can provide a new experience for students	4
Practical and Simple	6. 3D miniature solar system learning media is suitable for elementary school students	4
	7. 3D miniature solar system learning media is suitable for students' needs	4
	8. Instructions for using the solar learning media are easy to understand	4
	9. The 3D miniature solar system learning media is easy to use	4
	10. The colors presented in the 3D miniature solar system learning media accurately represent the actual colors	3
Flexible	11. The use of the 3D miniature solar system learning media is in accordance with the learning time specified in the lesson plan	4
	12. The durability of learning media allows for repeated use	4

Continued **Table 6.**

Assessment Aspect	Assessment Indicators	Score
	1. 3D miniature solar system learning media can actively engage students during the learning process	4
Number of Values	**50**	
Maximum Score	**52**	

Based on Table 6, the results of the effectiveness level from the teacher response questionnaire above show that the total score given is 50 and the maximum score obtained is 52. From this data, the effectiveness test formula is calculated as follows.

$$\text{Assessment Percentage} = \frac{50}{52} \times 100\%$$
$$= 0.961 \times 100\%$$
$$= 96$$

From the results of the data calculation above, the effectiveness percentage of the teacher response questionnaire was 96%. The effectiveness criteria table shows that the effectiveness is in the 81%-100% range, which is classified as "Very Effective." In the response questionnaire for this study, teachers also provided comments and suggestions that this learning media is very unique, environmentally friendly, creatively designed, and helps students understand the learning material.

Table 7. Student Response Questionnaire on the Learning Media Trial

No.	Respondent	The media makes it easier to remember the material	The media provides new knowledge	The media provides new knowledge	Instructions for using media are easy to understand	Media is easy to use	The color presentation of the media represents the actual colors.	Value
1.	AAY	1	1	1	1	1	1	6
2.	AA	1	1	1	1	1	1	6
3.	ANR	1	1	1	1	1	0	5
4.	AALF	1	1	1	1	0	1	5
5.	ADA	1	1	1	1	1	0	5
6.	ANA	1	1	0	1	0	1	4
7.	AN	1	1	1	1	1	1	6
8.	DA	1	1	1	1	1	1	6
9.	DNA	1	1	1	1	1	1	6
10.	DVPS	1	1	1	0	1	1	5
11.	ELAF	1	1	1	1	1	1	6
12.	FASE	1	1	1	1	1	1	6
13.	KSAZ	1	1	1	1	1	1	6
14.	MHA	1	1	1	1	1	1	6
15.	MNZ	1	1	1	1	1	1	6
16	MN	1	1	1	1	1	1	6
17.	NNZ	1	1	1	1	1	1	6

Continued **Table 7.**

No.	Respondent	The media makes it easier to remember the material	The media provides new knowledge	The media provides new knowledge	Instructions for using media are easy to understand	Media is easy to use	The color presentation of the media represents the actual colors.	Value
18.	QACKS	1	1	1	1	1	0	5
19.	RNAR	1	1	1	1	1	1	6
20.	RAN	1	1	1	1	1	1	6
21.	RPS	1	1	1	1	1	1	6
22.	RM	1	1	1	1	1	1	6
23.	SFSP	1	1	1	1	1	1	6
24.	SIS	1	1	1	1	1	1	6
25.	YAG	1	1	1	1	1	1	6
Total Score								**143**
Maximum Score								**150**

Based on Table 7, the results of the effectiveness level from the student response questionnaire above show that the total score obtained is 143 and the maximum score obtained is 150. From this data, the effectiveness test formula is calculated as follows.

$$\text{Assessment Percentage} = \frac{143}{150} \times 100\%$$
$$= 0.953 \times 100\%$$
$$= 95\%$$

From the results of the data calculation above, the effectiveness percentage of the student response questionnaire is 95%. Looking at the effectiveness criteria table, it shows that the effectiveness criteria of 81%-100% is stated in the "Very Effective" criteria.

The results of the analysis of the above data show that the 3D miniature solar system learning media developed for sixth grade elementary school students is highly valid and effective. Based on the data obtained, the learning media developed is suitable for implementation in learning activities. The implementation of learning media is expected to enable students to be actively involved as a whole, as well as to make it easier for students to learn about the solar system, which cannot be seen directly by the naked eye, in Natural Sciences (IPA) lessons in sixth grade elementary school. This study is in line with previous research (Tomi Permadi, 2023), which states that solar system material is material that cannot be seen directly by the eye, so learning media is needed to explain in detail in visualizing the atmosphere of outer space in the classroom that cannot be reached by students.

4 Conclusion

The development of a 3D miniature solar system learning media for sixth grade elementary school students was developed using the ADDIE development model. This

study was conducted to measure the validity and effectiveness of the learning media. The level of validity was measured through media expert validation with a percentage of 100%, lesson plan experts obtained a percentage of 100%, and subject matter experts obtained a validity percentage of 100%. The level of effectiveness of the learning media was measured through the results of a questionnaire (response survey) given by teachers with a percentage of 96% and a questionnaire (response survey) given to students with a percentage of 95%. Based on the results of the validity and effectiveness percentages, the media is categorized as highly valid and highly feasible. Thus, the 3D miniature solar system learning media for sixth grade elementary school is feasible to be implemented. Through the implementation of learning media, it is hoped that students can be actively involved as a whole, as well as make it easier for students to learn material on the solar system in Natural Sciences (IPA) lessons in Grade VI of Elementary School. In addition, the implementation of 3D miniature solar system learning media can provide (create) a more interesting and meaningful learning experience that can have a significant positive impact on learning effectiveness in the classroom.

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